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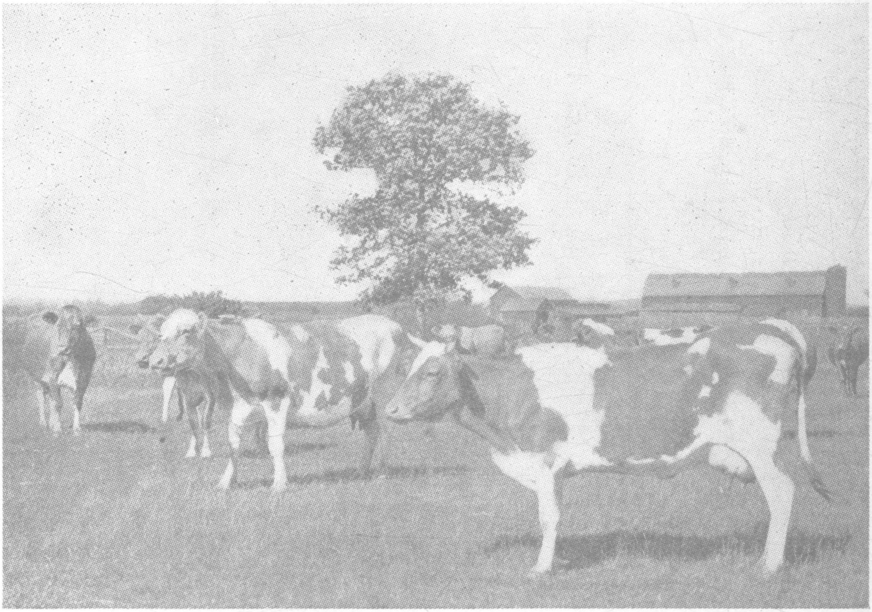
H. C. RAMSOWER, Director

Suggestions for Computing Rations for Dairy Cows

(Based on Ohio Cow Testing Association Records)



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Foreword

IT is a matter of common knowledge that different feeds produce different results. This is largely due to the difference in their composition. The successful feeding of dairy cattle is not possible without a knowledge of the composition of feeds and the relation they bear to the composition of the animal body.

It is not enough, in these days of narrow profit margins, for a dairyman to be content with mediocrity in either breed type or milk production. For maximum profit he must satisfy the bodily requirements of his animals at the lowest cost per feed unit, and also obtain the largest production for feed consumed.

On the following pages will be found suggestions for computing rations for dairy cows based on the records of the Ohio cow-testing associations; also some practical rations for dairy cows in Ohio and a list giving the amount of digestible nutrients in the common dairy feeds.

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Suggestions for

Computing Rations for Dairy Cows

(Based on Ohio Cow Testing Association Records)

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THE principal reason for the low average of milk and butter production thruout the State of Ohio is the lack of knowledge as to the proper feeding of the dairy cow. There are other reasons, also, which may be stated as follows:

1. Lack of ability on the part of the cow to convert food into milk.
2. Lack of dairy temperament, constitution, and capacity of the cow.
3. Lack of proper amounts of wholesome feed.
4. Lack of proper kinds of feed.
5. Lack of care.
6. Poor judgment on part of feeder.
7. Irregularity in milking and feeding.
8. Lack of sufficient quantity of pure water.

These reasons are all important ones. The fact remains, however, that no matter how well bred a cow may be or how closely she may conform to dairy type and temperament, if she is not fed and cared for properly she will not make a profitable producer.

Production Dependent on Feeding

It is true that a cow of dairy type and temperament, if in good condition, will give a large amount of milk for a time on a ration containing just enough nutrients for her maintenance, drawing on her body for the remainder of the nutrients that are lacking in the ration. If this method of feeding is persisted in, however, in time the cow will gradually decline in production as her reserve supply of body nutrients is used up. When this occurs it is usually impossible to bring the cow back to her maximum milk production, no matter what is fed. Therefore, if the dairyman is to get the maximum profit from his cow he must supply feeds in such quantity and of such quality as are most conducive to heavy production.

In order to keep the cow at her maximum production, it is up to the dairyman to know the steps to take and conditions under which to keep her. Every dairyman knows that in the spring ,when grass is plentiful and the heat is not excessive the cow produces more milk than at any other time of the year. Why is this? Because she gets abundance of palatable, succulent food, that makes up nearly a balanced ration; also, the temperature is moderate and the cow is comfortable. In order to have the cow do her best, we must strive to imitate these conditions as nearly as possible thruout the year. To have such uniformity for the cow we must keep the following points in mind: Keep the cow supplied with

1. Comfortable, well lighted and well ventilated quarters.
2. An abundance of fresh water of uniform temperature.
3. A liberal amount of succulent feeds.
4. Palatable feeds.
5. A variety of feeds.
6. Plenty of protein.
7. A liberal amount of bulky food to keep her satisfied.
8. The required amount of mineral substance.

How to Avoid Haphazard Feeding

To avoid haphazard feeding it is necessary for the dairyman to understand in a general way the composition of the animal body, the composition of milk, and the composition of feeds. In discussing "composition," it is necessary to make use of the chemical terms *element* and *compound.* An element is the simplest substance known—one that cannot be separated into a simpler or different substance. Elements do not occur in a free form in feeds, but make compounds—as for instance, protein in feed is a compound composed mostly of the elements carbon, hydrogen, oxygen, and nitrogen.

The dairyman, to compute a ration intelligently, should know how these various compounds in feeds are used in producing certain other combinations of elements in the animal body. Protein in feed, for instance, builds protein tissue in the animal body. This is discussed more fully below.

Composition of the Animal Body

The animal body is made up of water and dry matter (ash or mineral matter, protein, carbohydrates, and fats) which comes from the food.

Water The animal body when it comes to the point of quantity is largely made up of water. From 40 to 85 percent of its gross weight, varying according to its age and condition, consists of water. The water in the animal body serves four purposes: (1) It is a part of all bone and flesh; (2) it serves as a carrier of food from the digestive tract to body cells wherever they may be located, or from those parts of the body where the food is put into suitable shape to be used by the cells; (3) water removes the wastes of the body thru perspiration and the urine; and (4) it equalizes the temperature of the body.

Ash Ash or mineral matter is largely found in the bones or skeleton of the body, while other portions of the body may carry small quantities. From 2 to 5 percent of the gross weight of the frame is ash. The ash of the animal body consists largely of phosphate of lime. Since ash exists in plentiful quantities in most rations, it need not be considered in a ration, except for young stock or cows producing large quantities of milk.

Protein The protein is a very important constituent in the animal body, and contains from 12 to 19 percent nitrogen. The flesh, skin, bones, (in part) casein and albumin of milk, vital organs, brains, nerves—in fact, the bodily mechanisms are made up of proteins diluted, so to speak, with water, supported by the ash of the skeleton and rounded out with fat and with water. Protein is a compound made up largely of four elements, carbon, oxygen, hydrogen, and nitrogen.

Carbo-hydrates The carbohydrates of the body are made up of carbon, hydrogen, and oxygen. Very few carbohydrate substances exist in the body except in the blood. These substances are taken from the blood to furnish the energy of the muscles and part of the heat of the body. The liver acts as a storehouse for carbohydrates and regulates the supply to the blood so that the amount of carbohydrates in the blood is kept uniform for properly supplying the muscles. It is also thought that the liver has the power to make carbohydrates from fats and the protein of the food, if the supply of carbohydrates is limited.

Fats These are distributed thruout the body and comprise from 6 to 30 percent of the live weight of animals. They consist of carbon, hydrogen, and oxygen, but contain no nitrogen. They are used to supply energy to the cow and also furnish heat. The fats in the body of the cow are used as a storehouse for heat and energy. They are added to when the food supply is in excess of that needed by the cow for work or production, and they are drawn from when the food supply is short.

Composition of Milk

The composition of milk varies according to breed, individuality, and the lactation period, but the average is about as follows: Water 87.3 percent, butterfat 3.5 percent, milk sugar 5 percent, casein 2.7 percent, albumin .8 percent, ash .7 percent. Milk is a great deal like the animal body, as it contains about the same kind of complex substances. However, in milk we have more water and less solid matter.

Composition of Feeds

The composition of vegetable matter is made up in a way of substances similar to that of animal matter. Vegetable matter consists of water and dry matter (ash, protein, fat, and carbohydrates, which includes crude fiber and nitrogen-free extract). The dry matter or compounds in vegetable matter vary in proportion and somewhat in composition. In most cases these compounds are not in the proper proportions for the best results, so it is necessary for the dairyman to mix a number of these feeds to supply the cow with the desired nutrients. From the dairyman's standpoint only three of these food compounds need be considered because the ash or mineral matter usually is present in sufficient amounts. These three compounds (called nutrients) are protein, carbohydrates, and fat.

Protein in Feeds The protein of vegetable matter is a compound composed mostly of carbon, hydrogen, oxygen, and nitrogen. This compound is used to keep up the protein of the body, such as replacing worn-out tissues, building new tissues, for growth of hair, hoofs, horns, and for supplying the milk with casein and albumin. Protein cannot be produced in the animal body from carbohydrates and fats of food.

If there is an excess of protein fed in the ration, it will be used in the production of heat and energy, thus serving the purpose of carbohydrates and fats. Feeds rich in protein are usually higher in price, and while it is always necessary to have a *sufficient* amount of protein in a ration, the heat and energy demands of the animal body can be more economically met by feeding carbohydrates and fats.

The amount of digestible protein in feed varies from less than 1 percent to more than 40 percent.

Carbohydrates in Feeds Carbohydrate is a nutrient which differs from protein in that it does not contain nitrogen but is made up largely of carbon, hydrogen, and oxygen. It is abundant in our common grasses in the form of starch, sugar, fiber, etc., and is used by the cow to supply energy, heat, and fat in the body, and sugar and fat in the milk. It is the cheapest nutrient in our feeds, because it is most abundant; also, it is used in larger quantities by the cow than protein or fat.

Fats in Feeds These compounds are made up of nearly the same elements as carbohydrates, and are used by the animal in about the same way. Fats differ from carbohydrates in that they have a heat and energy value equal to about two and one-fourth times the energy of the same weight of carbohydrates.

The Importance of a Balanced Ration

The feed which a cow takes into her digestive system is utilized in the following ways:

1.—To support life..... $\begin{cases} \text{To maintain body temperature} \\ \text{To repair and replace body tissues} \\ \text{For the muscular activity of the vital processes} \end{cases}$

2.—To produce fat, flesh, or milk

3.—To perform labor (transform feed into milk)

4.—To develop the fetus

It is evident that the cow, to perform all these functions, must have a ration that contains the various nutrients in the proportions in which she needs them. In order for a dairyman to be able to calculate a practical ration, therefore, it is necessary for him to know in a general way the amount of digestible nutrients it takes for a cow to support life, to yield production, to perform labor, and to reproduce life.

Amounts of Nutrients Needed

To Support Life For the average 1000-pound cow at rest it takes .7 pound of protein, 7 pounds of carbohydrates, and .1 pound of fat for daily maintenance.

For each 100 pounds live weight the cow may exceed or fall below 1000 pounds there is added or subtracted one-tenth of the maintenance ration.

To Produce Milk In addition to this maintenance ration the cow will require feed containing the amounts of nutrients that are found in the milk that she produces. For instance, in 100 pounds of average milk there are 3.5 pounds of protein (casein and albumin), 5 pounds of carbohydrates (milk sugar), and 3.5 pounds fat (see "Composition of Milk"). If the cow is producing 50 pounds of 3.5 percent milk, half of these nutrients, or 1.75 pounds of protein, 2.5 pounds of carbohydrates, and 1.75 pounds of fat, should be added to the ration. If the supply of milk is less than 50 pounds, the nutrients may be reduced in proportion.

*For Growth and Other Functions** In order for a cow to perform her daily functions successfully and also develop a good fetus, she must have extra nutrients beside the requirements for daily maintenance and milk. Usually it takes about twice as much protein, and nearly the equivalent in carbohydrates and fat, as it takes for daily maintenance. In case a cow is

*According to the Ohio cow-testing association records a cow should have, in addition to requirements for maintenance and production, the amounts of nutrients here given, for growth, for production of fetus, and for energy required in transforming feed into milk.

producing milk and not developing a fetus, this protein should be reduced one-half, making the ration the same as it takes for daily maintenance.

When an undeveloped heifer is producing milk and also developing a fetus, she must have additional maintenance in order to make her mature.

Complete Ration

For example, a 1000-pound cow developing a fetus and producing 50 pounds of 3.5 percent milk daily, fed under average farm conditions, would require the following nutrients:

	Protein Pounds	Carbohydrate Pounds	Fat Pounds
For maintenance	.70	7.0	.10
In 50 pounds of 3.5 percent milk	1.70	2.5	1.75
For growth and other functions	1.40	7.0	.10
Total	3.80	16.5	1.95

Nutritive ratio—$1.95 \times 2.25 = 4.38$; $4.38 + 16.5 = 20.88$; $20.88 \div 3.80 = 5.5$. The nutritive ratio, therefore, is 1 part of protein to 5.5 parts of carbohydrates and fat, or 1:5.5. (See page 9 for further explanation of nutritive ratio.)

Since carbohydrates and fats perform the same functions, a ration may have less fat and more carbohydrates, or vice versa, and produce the same results, but a dairyman calculating a ration must bear in mind that *no compound takes the place of protein in feed to produce the protein in milk and the animal body.*

Points to Observe in Calculating a Ration

In calculating a ration for a dairy cow, the dairyman should keep in mind the following suggestions: The ration should be (1) economical, (2) palatable, (3) bulky, (4) succulent; it should have (5) plenty of variety, (6) plenty of protein, (7) plenty of mineral matter, and (8) the nutritive ratio should be considered. These important points will be taken up at length in the following paragraphs, except the nutritive ratio, which will be discussed under a separate heading.

Cost of a Ration

Without doubt, the cost of a ration is one of the most important factors to be considered by the dairyman. However, the other factors must not be sacrificed for cost in every case. To determine the cost of a ration in a rough way, which is sufficient in most cases, calculate the cost of a pound of nutrients (fats multiplied by 2.25 plus carbohydrates plus protein) in the different feeds available. The total amounts of nutrients in the common dairy feeds are shown on pages 14-16. Example: If corn is worth $1.50 per hundred, one pound of nutrients will cost 1/85.7 of $1.50, or 1.8 cents. If oats is worth $1.50 per hundred, one pound of nutrients will cost 1/70 of $1.50, or 2.1 cents. The most economical feeds are those that will yield nutrients cheapest, provided the seven other factors in calculating a ration are taken into consideration. To make a more accurate determination of the cost of a ration, the cost per pound of protein, carbohydrates, and carbohydrate equivalents must be calculated. Directions for these calculations are given on page 16.

Palatability

If the best results in production are to be obtained, a ration should always be made palatable. Succulence and seasoning (such as molasses and salt) in a ration make it a great deal more appetizing. Musty, moldy, or damaged food should not be fed to any animal.

Bulkiness All rations for dairy cows should have a certain amount of bulk: First, to satisfy the cow; second, to lighten a ration for the purpose of aiding the cow in digesting out the digestible portions of the feed; third, to lighten the ration and prevent the cow from overfeeding and getting sluggish.

Succulence Succulent feeds are those that contain a large percentage of water and are green or possess the properties of green feeds. Such feeds are very palatable, easy and quick to digest, and tend to keep the bowels of the animals loose, which is natural in cattle; therefore they are valuable for feeding with dry feeds during the winter season. June grass is our best succulent feed. If the cow is fed a little grain along with good June pasture she will produce more milk than at any other time of the year. Therefore it is up to the dairyman to imitate these conditions as nearly as possible thruout the year in order to get the maximum production. Since silage is easy to produce, handle, and preserve, it is the most important feed in this class. Mangel and sugar beets are very good succulent feeds, but on account of the cost of production they are not practical for economical milk production. For official and semi-official records, it is advisable and practical to feed some beets or mangels along with silage.

Variety Variety in a dairy ration is necessary to stimulate the cow's appetite and avoid trouble caused from the lack of certain nutrients in plants or the effect of some of the plant nutrients on the cow's anatomy. For instance, some plants are very low in mineral content, while others are high. Other plants are made up of very inferior grades of protein, and would be harmful to a cow if fed alone. On the other hand, some plants have a poor conditioning effect on the cow and others have the opposite effect.

Protein When corn and corn silage are fed in abundance, which happens in the majority of the dairy states, carbohydrates and fats in feeds usually take care of themselves and so do not need much consideration in balancing a ration unless the dairyman wants to know the nutritive ratio (protein to carbohydrates and carbohydrate equivalents). In too many instances dairymen do not feed sufficient amounts of protein to meet the cow's requirements. It is always safest to slightly overfeed in protein, for protein is the only nutrient in feed that supplies the cow with the nitrogen that she must have, to produce her maximum flow of milk, keep up her body maintenance, promote growth, and perform labor. A ration for a dairy cow producing a good flow of milk should have a nutritive ratio of 1:6 or narrower—1:5.5 or 1:5 is better. For growing heifers producing a very large flow of milk one could use a ration as narrow as 1:4.5. For the youngest animals the ration should be as narrow as 1:4. If the dairyman does not understand calculating the nutritive ratio, made up a ration that contains from 17 to 20 percent protein, keeping in mind the other seven essentials. The amount of protein present in feeds is shown in the list of "Average Digestible Nutrients in Common Dairy Feeds," pages 14-16.

Mineral Content In the majority of feeds that the dairy cow receives, the mineral matter, or ash, is sufficient to supply the cow with the necessary needs. In case the dairyman is compelled to furnish the cow with feeds low in mineral content, such as cornmeal, hominy, gluten, and other highly concentrated feeds, it is advisable to add bone flour in addition to salt to the grain ration. Add 1 pound of bone flour, 1 pound of pulverized limestone, 2 pounds of charcoal, and 1 pound of salt to each 100 pounds of feed. Besides adding salt to the ration, the cow should always have access to it in the field or barn.

Calculating the Nutritive Ratio

The nutritive ratio is the ratio of the protein to the carbohydrates and fats in any ration. As already shown, in the production of energy and heat, fat has about two and one-fourth times the value of carbohydrates; therefore, in computing the nutritive ratio of a ration, the amount of fat is multiplied by 2.25 and the product added to the amount of carbohydrates, and this sum divided by the amount of protein. The ratio of one to the quotient is the nutritive ratio.

For example: cornmeal has 6.9 percent protein, 69 percent carbohydrates, and 3.5 percent fat; or, stated in another way, 100 pounds of cornmeal will contain 6.9 pounds of protein, 69 pounds of carbohydrates, and 3.5 pounds of fat; what is the nutritive ratio?

The calculation is usually made as follows: 3.5 (fat) multiplied by 2.25 equals 7.87; 7.87 plus 69 (carbohydrates) equals 76.9 carbohydrate equivalents; 76.9 divided by 6.9 equals 11.1, or a nutritive ratio of 1:11.1. This is too wide a ratio for a dairy cow producing a large flow of milk. According to Haecker and many others, a mature cow producing milk will require a ration that has a nutritive ratio of 1:6 or 1:6.5. If a cow is kept in the best of quarters, cared for under the best of conditions, and given the best of food that has a known digestibility, a ration that has a nutritive ratio of 1:6 or 1:6.5 will satisfy her needs. But where a cow is kept under average farm conditions, developing a calf, and fed commercial feeds or feeds that are not No. 1, the ratio should be as narrow as 1:5.5 or 1:5 for the best results. The majority of our big record cows in Ohio are fed rations even narrower than 1:5. If our best cows are developed with such narrow rations, why isn't it practical for the average dairyman in Ohio to imitate such feeding?

Water an Essential Requirement

In addition to the eight preceding essentials in a ration, the dairyman needs to supply the cow with a liberal amount of fresh water daily, for the body is composed of nearly 80 percent water and milk is close to 87 percent. It is necessary to keep the water content of the body up to its maximum in order to provide a perfect medium for the transfer of the food material from different parts of the body to other parts, to render the best assistance in the elimination of waste matter, to make and keep up her maximum milk production, and to equalize the temperature of the body. No cow can keep her body up to the maximum water content unless she has water before her the entire time. Then, Mr. Dairyman, a low water content in the cow's body means a shortage of milk.

General Suggestions on Feeding

Roughage

Silage—Feed 4 pounds per 100 pounds live weight.

Hay with silage—Feed 1 to 1.5 pounds per 100 pounds live weight.

Hay without silage—feed 2 to 2¼ pounds per 100 pounds live weight.

Concentrates

For Holstein and Ayrshire cows, producing

- Less than 30 lbs. milk daily, feed 1 lb. concentrates to each 3.5 lbs. milk
- From 30 to 50 lbs. milk daily, feed 1 lb. concentrates to each 4 lbs. milk
- From 50 to 100 lbs. milk daily, feed 1 lb. concentrates to each 4.5 lbs. milk

For Jersey and Guernsey cows, producing

- Less than 30 lbs. milk daily, feed 1 lb. concentrates to each 3 lbs. milk
- From 30 to 50 lbs. milk daily, feed 1 lb. concentrates to each 3.5 lbs. milk

Another rule for feeding concentrates is to feed the same number of pounds of concentrates daily as the cow produces pounds of butterfat in a week.

No matter which system of feeding is selected, never feed less than 4 pounds grain daily, unless the cow gets in too high condition, which seldom happens. Cows on average Ohio pastures should receive the same amount of grain as if on dry feed.

When rough feeds and concentrates are fed according to the above rules, and cornmeal or corn and cob meal makes up part of the concentrated mixture, the carbohydrate and fats usually take care of themselves and do not need much consideration in balancing up a concentrated mixture. The amount of protein needed in a concentrated mixture will depend on the roughage fed.

For example:

When alfalfa, sweet clover, soybean hay, or pasture is fed with or without silage the concentrated mixture should contain from 11 to 13 percent protein.

When red, alsike, or mammoth clover hay is fed with or without silage, the concentrated mixture should contain from 15 to 17 percent protein.

When mixed hay is fed with or without silage, the concentrated mixture should contain from 18 to 20 percent protein.

When timothy hay or stover is fed with or without silage, the concentrated mixture should contain from 22 to 24 percent protein.

An Average Ration Analyzed

A 1000-pound cow producing 50 pounds of 3.5 percent milk daily should have about 40 pounds of corn silage, 15 pounds of alfalfa hay, and 12 to 13 pounds of 13 percent protein grain mixture daily. According to the Feed Table on pages 14-16, 100 pounds of corn silage contains the following digestible nutrients:

	Protein Pounds	Carbohydrates Pounds	Fat Pounds
100 pounds corn silage.................	1.1	15.0	.7

40 pounds of corn silage would contain:

$40 \times .011 = .44$ pound protein

$40 \times .150 = 6.00$ pounds carbohydrates

$40 \times .007 = .28$ pound fat

According to the Feed Table, alfalfa hay contains the following nutrients:

	Protein Pounds	Carbohydrates Pounds	Fat Pounds
100 pounds alfalfa hay.................	10.6	39.00	0.90

15 pounds alfalfa hay would contain:

$15 \times 10.6 = 1.59$ pounds protein

$15 \times 39.0 = 5.85$ pounds carbohydrates

$15 \times 0.9 = 0.135$ pound fat

According to the Feed Table, in Grain Mixture No. 1 will be found the following digestible nutrients:

	Protein Pounds	Carbohydrates Pounds	Fat Pounds
150 pounds cornmeal..................	10.35	103.50	5.25
100 pounds wheat bran................	12.50	41.60	3.00
25 pounds linseed meal................	7.55	8.15	1.67
25 pounds cottonseed meal (43%)......	9.25	5.45	2.15
Average, 100 pounds...............	13.22	52.90	4.30

13 pounds grain mixture would contain:

$13 \times 13.22 = 1.72$ pounds protein
$13 \times 52.9 = 6.877$ pounds carbohydrates
$13 \times 4.03 = 0.524$ pound fat

Recapitulation: Total nutrients in silage, alfalfa hay, and grain:

	Protein Pounds	Carbohydrates Pounds	Fat Pounds
40 pounds corn silage	.44	6 000	.280
15 pounds alfalfa	1.59	5.850	.135
13 pounds grain mixture No. 1	1.72	6.877	.524
Total nutrients	3.75	18.727	.939

This ration will have the following nutritive ratio: .939 pound fat multiplied by 2.25, plus 18.727 pounds carbohydrates, equals 20.84 carbohydrate equivalents, divided by 3.75, equals 5.5, or a nutritive ratio of 1:5.5.

A 1000-pound cow developing a fetus and producing 50 pounds of 3.5 percent milk daily would need a ration having the following nutritive ratio:

	Protein Pounds	Carbohydrates Pounds	Fat Pounds
Maintenance	.70	7.0	.10
Growth and other functions	1.40	7.0	.10
50 pounds 3.5 percent milk	1.70	2.5	1.75
Total nutrients	3.80	16.5	1.95

Nutritive ratio $1.95 \times 2.25 + 16.5 = 20.888$; $20.888 \div 3.80 = 5.5$, or a nutritive ratio of 1:5.5.

Practical Rations for Cows Fed Under Ohio Conditions

When alfalfa, sweet clover, soybean hay, or pasture is fed with or without silage, the following grain mixture is advisable:

Grain Mixture (No. 1)

150 pounds cornmeal or corn and cob meal
100 pounds ground oats or bran
25 pounds cottonseed meal (43 percent)
25 pounds linseed meal or soybean meal

When red, alsike, or mammoth clover is fed with or without silage, the following grain mixture is advisable:

Grain Mixture (No. 2)

100 pounds cornmeal or corn and cob meal
100 pounds bran or ground oats
25 pounds cottonseed meal (43 percent)
50 pounds linseed meal or soybean meal

When mixed hay is fed with or without silage, the following grain mixture is advisable:

Grain Mixture (No. 3)

100 pounds cornmeal or corn and cob meal
100 pounds bran or ground oats
50 pounds cottonseed meal (43 percent)
100 pounds linseed meal or soybean meal

When stover or timothy hay is fed with or without silage, the following grain mixture is advisable:

Grain Mixture (No. 4)

100 pounds cornmeal or corn and cob meal
100 pounds bran or ground oats
100 pounds cottonseed meal (43 percent)
150 pounds linseed meal or soybean meal

When barley is fed in a ration, substitute it for oats or corn pound for pound.

When ground wheat or wheat middlings is fed in a ration, substitute it for part of the cornmeal. Never have more than 25 percent of the grain mixture ground wheat or wheat middlings.

When high-grade gluten meal is fed in a ration, substitute it for cottonseed meal. Add 25 percent more gluten meal than cottonseed meal.

When high-grade gluten feed or low-grade gluten meal is fed in a ration, substitute it for cottonseed meal. Add 60 percent more gluten feed, or low-grade gluten meal, than cottonseed meal.

Ration No. 1 is recommended by the Agricultural College Extension Service of the Ohio State University as one for the economical production of milk, because it makes use of the maximum amount of home-grown feeds and a minimum amount of purchased concentrates.

Feeding the Young Calf

In every case the young calf should always get the first milk or colostrum which is designed by nature to start the digestive functions. If the calf is left with the cow for the first few days, it should not be allowed to gorge itself on milk, in case the cow is a heavy milker. After each feeding the cow should be stripped clean. When the cow's udder is caked, leaving the calf with her will aid in reducing the inflammation. When the calf is fed from the pail, it should not be given too large an allowance of milk, for overfeeding produces indigestion and scours. The young calf at first should receive from 5 to 8 pounds of milk daily, depending on its size. For the first week it is a good practice to feed the calf three times daily and then drop to two feedings daily. The milk should be sweet and have a temperature of blood heat when fed. As the calf grows older, the milk should be gradually increased from 7 to 12 pounds daily, depending on the size and vigor of the calf. When the calf is from 2 to 4 weeks old, the exact age depending on its vitality, skimmilk may gradually replace the whole milk, the change usually being made at the rate of ½ to 1 pound or slightly more per day, 1 week or 10 days being required to get the calf on skimmilk alone. In case a cow gives milk that is too rich, it should be diluted with skimmilk so that it will not test more than 4 percent butterfat. Some calves are delicate and are easily overfed. In such cases a safe rule to follow is keep them a little hungry. Calves should always be fed milk individually, for some drink faster than others.

For dairy calves receiving a milk ration, feed one of the following grain rations.

Grain Ration No. 1	*Grain Ration No. 2*
30 pounds hominy	30 pounds cracked corn
30 pounds bran	30 pounds ground oats
30 pounds barley	30 pounds bran
10 pounds linseed meal	10 pounds linseed meal

The small calf receiving milk should not be overfed with grain, but should have what it will clean up. Besides grain, the calf should be given a liberal amount of clover hay, clover and alfalfa hay, or pasture. After it will take silage, give it a small feed once a day. Too much silage or alfalfa hay may cause the calf to scour. Besides grain, hay, and silage, the calf should have access to salt and water the entire time. In case the young calf scours, mix a small tablespoon of dried blood with each feed of milk. If the milk supply is limited so the calf does not get its quota, make a thick gruel of hot water and equal amounts of wheat flour, hominy flour, linseed meal, and blood meal and mix with the milk you have for the calf. Do not feed this substitute until the calf is from 4 to 6 weeks old. Start with two tablespoons of this mixture of meals at a feed, and care should be taken not to overfeed.

Feeding the Dry Cow

If a cow is hard to dry off, care should be taken not to let her udder cake or spoil. Such carelessness often causes a cow to freshen with a blind quarter. Sometimes by feeding a cow timothy hay or corn stover along with a small amount of corn and oat chop, she will dry off more readily. After she is dry and her udder is in good condition feed her about 4 pounds of one of the following grain mixtures daily, with pasture, or some legume hay and silage. Heifers should be fed the same way. For a few days previous to calving, practically all of the grain should be withdrawn, as grain feeding at this time has a tendency to cause udder trouble.

Grain Mixture No. 1

100 pounds cornmeal
100 pounds ground oats
100 pounds wheat bran
50 pounds linseed meal

Grain Mixture No. 2

100 pounds hominy
100 pounds ground barley
100 pounds wheat bran
50 pounds linseed meal

Grain Mixture No. 3

100 pounds corn and cob meal
100 pounds wheat bran
25 pounds linseed meal

Feeding the Fresh Cow

The first feed for the fresh cow should be either ground oats steamed, or a hot bran mash with a small amount of oil meal. The cow should be given all the lukewarm water she will take. Cold water tends to cause a retention of the afterbirth. The oats or bran mash should be fed for a couple of days, after which the regular grain ration may be substituted. The amount to be given at first depends somewhat on the cow, but not more than half of a full grain ration should be given. Ordinarily a cow should not be put on a full grain ration until three weeks after freshening.

Feeding the Herd Sire

In too many cases the herd sire, after reaching maturity, is fed too much grain and succulent feed. Such feeding often causes a sire to become sluggish and not a sure breeder. A mature sire should have all the clover that he will consume, a very small amount of silage (about 8 to 10 pounds daily), along with one of the grain mixtures suggested for dry cows and heifers, to keep him in good, thrifty condition. Three or four pounds of grain daily is usually sufficient. Young bulls should be fed proportionately more so as to keep them thrifty and growing.

Average Digestible Nutrients in Common Dairy Feeds

Feedstuff	Total dry matter in 100 lbs.	Digestible nutrients in 100 lbs. Crude protein	Carbo-hydr'ts	Fat	Total	Nutri-tive ratio
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	1:
Alsike clover hay, all analyses......	87.7	7.9	36.9	1.1	47.3	5.0
Alsike clover, in bloom.............	21.5	2.3	10.4	0.4	13.6	4.9
Alfalfa, green, all analyses.........	25.3	3.3	10.4	0.4	14.6	3.4
Alfalfa hay, all analyses...........	91.4	10.6	39.0	0.9	51.6	3.9
Alfalfa, first cutting...............	91.5	9.3	39.0	0.6	49.7	4.3
Alfalfa, second cutting.............	92.7	11.2	40.2	0.7	53.0	3.7
Alfalfa, third cutting..............	91.1	10.2	37.1	0.8	49.1	3.8
Alfalfa, fourth cutting.............	84.0	11.1	33.6	0.7	46.3	3.2
Alfalfa silage......................	24.6	1.2	7.8	0.6	10.4	7.7
Barley, grain.......................	90.7	9.0	66.8	1.6	79.4	7.8
Barley, hay, common................	92.6	4.6	48.2	0.9	54.8	10.9
Barley, straw.......................	85.8	0.9	40.2	0.6	42.5	46.2
Bean, navy, cull....................	87.2	18.3	54.3	0.8	74.4	3.1
Beet, common.......................	13.0	0.9	9.1	0.1	10.2	10.3
Beet, sugar.........................	16.4	1.2	12.6	0.1	14.0	10.7
Beet Pulp..........................	91.8	4.6	65.2	0.8	71.6	14.6
Buckwheat	87.9	8.1	49.7	2.5	63.4	6.8
Buckwheat, middlings..............	88.0	24.6	38.3	6.1	76.6	2.1
Buckwheat bran, high grade........	88.8	10.5	30.4	3.2	48.1	3.6
Buckwheat bran, low grade.........	89.9	2.4	21.4	1.7	27.6	10.5
Cabbage	8.9	1.9	5.6	0.2	7.9	3.2
Clover and mixed grass hay........	89.9	4.7	39.9	1.3	47.5	9.1
Clover and timothy hay.............	87.8	4.0	39.7	1.1	46 2	10 6
Clover silage......................	27.8	1.3	9.5	0.5	11.9	8.2
Cocoanut meal, low in fat..........	90.4	18.8	42.0	8.1	79.0	3.2
Cocoanut meal, high in fat.........	92.3	18.4	37.6	17.1	94.5	4.1
Corn fodder, green, all analyses.....	21.9	1.0	12.8	0.4	14.7	13.7
Corn, dent..........................	89.5	7.5	67.8	4.6	85.7	10.4
Corn meal or chop.................	88.7	6.9	69.0	3.5	83.8	11.1
Corn-and-cob meal..................	89.6	6.1	63.7	3.7	78.1	11.8
Corn fodder (ears, if any, remaining, from barn or arid districts).......	91.0	3.5	51.7	1.5	58.6	15.7
Corn stover (ears removed).........	90.6	2.2	47.8	1.0	52.2	22.7
Corn silage, well matured, recent analyses	26 3	1.1	15.0	0.7	17.7	15.1
Corn silage, from field cured stover.	19 6	0.5	9.9	0.4	11.3	21.6
Corn and clover silage.............	28.6	2.1	15.9	0.7	19.6	8.3
Corn and soybean silage............	24.7	1.6	13.8	0.8	17.2	9.8
Cottonseed meal. choice............	92 5	37.0	21.8	8 6	78 2	1.1
Cottonseed meal, prime............	92 2	33.4	24.3	7 9	75.5	1.3
Cottonseed meal, good.............	92.1	31.6	25 6	7.8	74.8	1.4
Cowpea, hay, all analyses..........	90.3	13.1	33.7	1.0	49.0	2.7

* This table was taken from the Seventeenth Edition of "Feeds and Feeding" by Henry & Morrison.

Feedstuff	Total dry matter in 100 lbs.	Digestible nutrients in 100 lbs.				Nutritive ratio
		Crude protein	Carbohydr'ts	Fat	Total	
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	1:
Cowpea, seeds	88.4	19.4	54.5	1.1	76.4	2.9
Cowpeas and corn, green	20.0	1.3	11.4	0.3	13.4	9.3
Cowpeas and oats, green	21.8	3.3	9.1	0.6	13.8	3.2
Cowpeas and sorghum, green	18.7	0.7	10.0	0.3	11.4	15.3
Crimson clover hay	89.4	9.7	36.8	1.0	48.7	4.0
Field peas, hay	88.9	12.2	40.1	1.9	56.6	3.6
Field pea hay without peas	90.6	7.7	47.0	0.9	56.7	6.4
Field peas, green	16.6	2.9	7.1	0.3	10.7	2.7
Field pea seeds	90.8	19.0	55.8	0.6	76.2	3.0
Flaxseed	90.8	20.6	17.0	29.0	102.8	4.0
Gluten feed, high grade	91.3	21.6	51.9	3.2	80.7	2.7
Gluten feed, low grade	91.2	15.1	57.8	4.8	83.7	4.5
Gluten meal, high grade	90.9	30.2	43.9	4.4	84.0	1.8
Gluten meal, low grade	91.8	23.2	44.1	9.7	89.1	2.8
Hominy feed, high grade	89.9	7.0	61.2	7.3	84.6	11.1
Hominy feed, low grade	90.9	6.3	64.1	5.6	83.0	12.2
Kentucky bluegrass hay, all analyses	86.8	4.7	43.5	1.5	51.6	10.0
Linseed meal, old process	90.9	30.2	32.6	6.7	77.9	1.6
Linseed meal, new process	90.4	31.7	37.9	2.8	75.9	1.4
Mammoth clover hay	81.3	6.4	37.2	1.8	47.6	6.4
Mangels	9.4	0.8	6.4	0.1	7.4	8.2
Millet hay, common	85.7	5.0	46.0	1.8	55.0	10.0
Molasses, cane or blackstrap	74.2	1.0	58 2		59.2	58.2
Molasses-alfalfa feeds	86.5	8.5	41.0	0.5	50.6	5.0
Oats, grain	90.8	9.7	52.1	3.8	70.4	6.3
Oats, ground, high grade	89.2	9.4	51.4	4.1	70.0	6.4
Oat straw	88.5	1.0	42.6	0.9	45 6	44.6
Oat hay	88.0	4.5	38.1	1.7	46.4	9.3
Peanut cake from hulled nuts	89.3	42.8	20.4	7.2	79.4	0.9
Peanut cake, hulls included	94.4	20.2	16.0	10.0	58.7	1.9
Peas and oats hay	83.4	8.3	37.1	1.5	48.8	4.9
Peas and oats, green	22.6	2.4	10.6	0.6	14.4	5.0
Pumpkin, field	8.3	1.1	4.5	0.5	6.7	5.1
Red clover hay, all analyses	87.1	7.6	39.3	1.8	50.9	5.7
Red clover, green. all analyses	26.2	2.7	13.0	0.6	17.1	5.3
Red dog flour	88.9	14.8	56 5	3.5	79.2	4.4
Redtop hay, all analyses	90.2	4.6	45.9	1.2	53.3	10.6
Rye hay, all analyses	91 9	2.9	41.1	1.1	46.5	15.0
Rye, grain	90.6	9.9	68.4	1.2	81.0	7.2
Rye middlings	88.6	12.6	55.5	3.1	75.1	5.0
Rye bran	88.6	12.2	56 6	2.8	75.1	5.2
Soybean hay	91.4	11.7	39 2	1.2	53.6	3.6
Soybeans, green, all analyses	23 6	3.2	10 2	0.5	14 5	3.5
Soybeans and corn, green	23.8	1.7	13.6	0.6	16 7	8.8
Soybean seeds	90.1	30.7	22.8	14.4	85.9	1.8

Feedstuff	Total dry matter in 100 lbs.	Digestible nutrients in 100 lbs.				Nutritive ratio
		Crude protein	Carbohydr'ts	Fat	Total	
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	1:
Soybean meal, fat extracted	88.2	38.1	33.9	5.0	83.2	1.2
Soybean silage	27.1	2.6	11.0	0.7	15.2	4.8
Sugar-beet leaves	11.6	1.2	6.3	0.1	7.7	5.4
Sugar-beet tops	11.4	1.7	5.4	0.1	7.3	3.3
Sweet clover hay (white)	91.4	10.9	38.2	0.7	50.7	3.7
Sweet clover hay (yellow)	91.3	10.0	35.9	0.5	47.0	3.7
Sweet sorghum fodder, green	24.9	0.7	14.1	0.6	16 2	22.1
Timothy hay, all analyses	88.4	3.0	42.8	1.2	48.5	15.2
Turnips	9.5	1.0	6 0	0.2	7.4	6.4
Velvet bean, seed	88.3	18.1	50.8	5.3	80.8	3.5
Velvet bean, seed and pod	87.7	14.9	51.7	3.8	75 2	4.0
Vetch, common, hay	92 9	11.6	42.8	1.6	58.0	4.0
Vetch, hairy, hay	87.7	15.7	37.1	1.9	57.1	2.6
Vetch and oats, green	26.5	2.8	13.3	0.4	17.4	5.1
Wheat, all analyses	89.8	9.2	67.5	1.5	80.1	7.7
Wheat middlings, standard, (shorts)	89 5	13.4	46.2	4.3	69.3	4 2
Wheat bran, all analyses	89.9	12.5	41.6	3.0	60 9	3.9
Wheat bran, low grade	90.0	7.5	41.4	3.3	56 3	6 5
Wheat feed (shorts and bran)	89 9	12 9	45.1	4.0	67 0	4.2
Wheat straw	91.6	0.7	35.1	0.5	36.9	51.7

To Calculate Cost of One Pound of Carbohydrates

1. Multiply cost of 100 pounds cornmeal* by the pounds of protein in 100 pounds cottonseed meal †
2. Multiply cost of 100 pounds cottonseed meal by the pounds of protein in 100 pounds cornmeal.
3. Multiply pounds of protein in 100 pounds cottonseed meal by the pounds of carbohydrates and equivalents in 100 pounds of cornmeal.
4. Multiply pounds of protein in 100 pounds cornmeal by the pounds of carbohydrates and equivalents in 100 pounds cottonseed meal.
5. Subtract No. 2 from No. 1.
6. Subtract No. 4 from No. 3.
7. Divide No 5 by No. 6 and the answer will be the cost of one pound of carbohydrates and equivalents.

To Calculate Cost of One Pound of Protein

8. Multiply cost of 100 pounds cottonseed meal by pounds of carbohydrates and equivalents in 100 pounds cornmeal.
9. Multiply cost of 100 pounds cornmeal by pounds carbohydrates and equivalents in 100 pounds cottonseed meal.
10. Multiply pounds protein in 100 pounds cottonseed meal by pounds carbohydrates and equivalents in 100 pounds cornmeal.
11. Multiply pounds protein in 100 pounds cornmeal by pounds carbohydrates and equivalents in 100 pounds of cottonseed meal.
12. Subtract No. 9 from No. 8.
13. Subtract No. 11 from No. 10.
14. D vide No. 12 by No. 13, and the answer will be the cost of one pound of protein.

* Any other available carbohydrate concentrate may be used throuout the calculation.

† Any other available protein concentrate may be used thruout the calculation